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Study on Parameter Optimization of Rectifying Circuit of Rectenna

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In Space Solar Power Satellite system (SPS), it is very important to develop the high RF-DC efficiency of rectennas that change microwave power into DC power. Since very huge rectenna is needed, we must make rectenna cheaply. So, we notice the substrate to mount a rectification circuit. In our research group, experimental examination on the height of substrate was carried out to solve the relation between RF-DC conversion efficiency and substrate parameters. Also in the rectification circuit that uses the glass epoxy (εr ~ 4.2) substrate whose characteristic is generally considered to be bad, we have obtained about 63% RF-DC conversion efficiency that was comparatively high efficiency. So it is believed that a certain amount of selection nature in the parameter of the substrate is necessary for realization of efficient rectennas. So, even if we don't use the expensive substrate like Teflon that is used mainly, it can be assumed that high efficiency is kept by using a cheap substrate.

The purpose of this study is to carry out detailed analysis and evaluation about the substrate parameter dependency of the RF-DC conversion efficiency through simulations. In this study, the dependency was examined for 4 parameters (εr: relative permitivity, tand, h: substrate thickness, and t: conductor thickness).

When an ideal microstrip line is taken into consideration, there was no dependency on εr. But since the influence by a manufacture error became large relatively if εr became large when the error of actual line length and width was taken into consideration, the decline of RF-DC conversion efficiency became large. If tand is 0.01 or less, high efficiency is maintainable. Even if the characteristic of the substrate is inferior to the expensive Teflon, high efficiency rectenna is realizable (Fig.1).

Next, we explain about the theoretical study of a rectifying circuit. In the past, we tried to develop a theory of the rectifying circuit. However, we can't realize how the rectifying circuit performs the RF-DC conversion in the high frequency band, especially the relation of the rectification and the circuit composition (the microstrip line between diode and output capacitance).

So, the purpose of this study is to clarify the theory of the rectifying circuit in the high frequency band. In this report, we derive the theoretical formula by taking the internal factors of a diode into consideration.

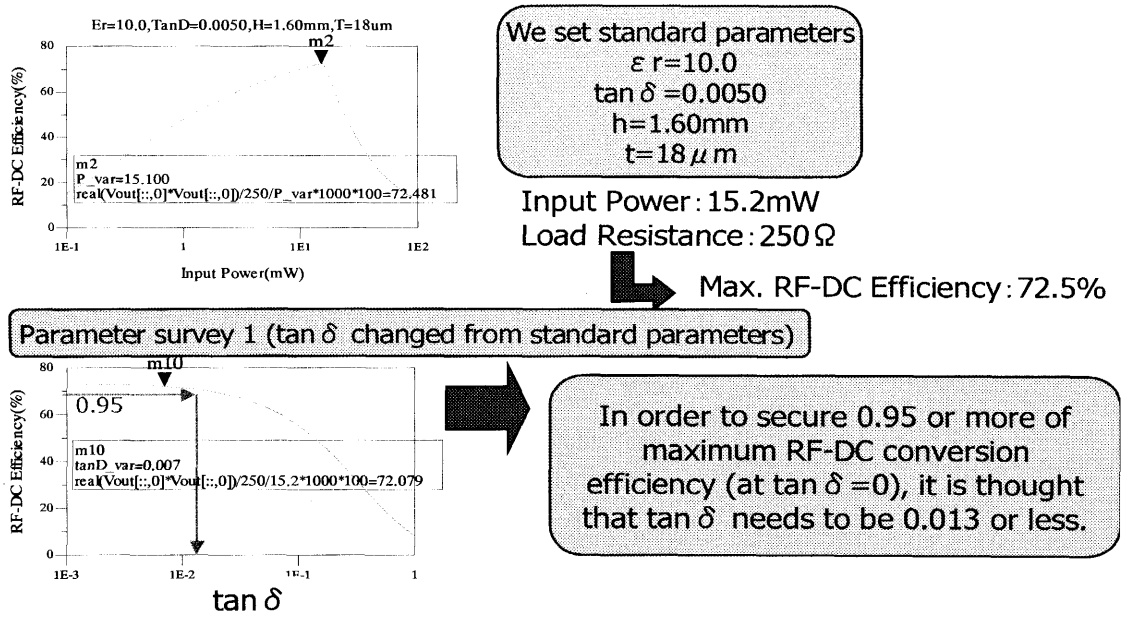

Fig. 1 Substrate parameter influence to RF-DC conversion efficiency in case of ideal microstrip lines